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PROJECT: BEACON EXPLORER-C (BE-C)

PRESS KIT

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SCHEDULED TO BE LAUNCHED NO EARLIER THAN MARCH 30.

NEWS NASA

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BEACON EXPLORER-C
USES 'TRAIN WHISTLE EFFECT'
IN EARTH MEASUREMENT

The National Aeronautics and Space Administration will launch no earlier than March 30 its newest satellite, using the "train whistle effect" of an orbiting radio signal to map irregularities in the Earth's gravitational field.

The Beacon Explorer-C (BE-C) will be the first NASA satellite with geodesy as its primary mission. Geodesy is the measurement of the Earth's size, shape, mass, and variations in gravity.

The "train whistle" effect refers to what scientists call the Doppler shift, the shift in frequency of a sound (or radio) wave received from a moving source.

As a train approaches a person standing near the track, he hears the whistle shifting to a higher frequency (higher pitch) than that actually emitted and to lower frequencies as the train passes and goes away.

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The size of the Doppler shift, or shift in pitch, depends on how fast the train is going, how far the listener is from the track and where the train is along the track. Thus, if the listener could measure the Doppler shift at several different times he could quickly compute where the train is with respect to where he is and how fast it is going.

If the Earth were a perfect sphere, a satellite would travel along a smooth curve called an ellipse. However, irregularities in the Earth's shape cause the orbit to be different and therefore cause the Doppler shift of radio signals from the spacecraft to be different from what would be expected for an elliptic orbit. It is by analysis of these slight changes that the shape of the Earth is figured out of the research program which uses the Doppler data.

A secondary mission objective will support the most extensive international cooperative space effort ever undertaken, involving 86 ground stations in 36 countries. This is a global survey of the electron content of cross-sections of the ionosphere, and measurements of electron densities and temperatures in the immediate vicinity of the spacecraft.

The ionosphere acts as a gigantic electrified mirror in space for relaying long-range radio communications. Free electrons play a vital role in this phenomena.

The new Explorer also will be equipped to evaluate further the use of laser (light amplification by stimulated emission of radiation) techniques in deriving orbital and geodetic information and for deep space communication.

A radio attenuation experiment will be contained on the second stage of the four-stage Scout launch vehicle.

As with the global survey of electron counts, the laser experimentation was pioneered by the first Beacon Explorer to achieve orbit, Explorer XXII, launched Oct. 9, 1964. Both projects are continuing with that successful spacecraft.

The 132-pound, windmill-shaped BE-C will be launched from NASA's Wallops Station, Wallops Island, Va., by a solid-propellant Scout. The planned near-circular orbit calls for a high point of about 670 miles (1,080 kilometers) and a low point of about 620 miles (1,000 kilometers). The plane of the orbit will be inclined 41 degrees to the Equator. The spacecraft will complete an orbit in about one hour and 45 minutes.

The spacecraft is expected to have an operating lifetime of about one year.

Explorer XXII and BE-C are physically identical except that the new satellite will fly a laser signal detector, a photo-sensitive device, designed to confirm strikes made by the ground-aimed light beam during experiments when the spacecraft passes within range.

Explorer XXII was launched by a Scout from Vandenberg AFB, Calif. (formerly the U.S. Navy's Pacific Missile Range), into an orbit inclined 80 degrees to the Equator. It still is providing excellent data, including geodetic information from its Doppler experiment.

The first Beacon Explorer, launched from Cape Kennedy, Fla., March 19 last year, did not achieve orbit due to a failure of the Delta launch vehicle.

Other satellites in the NASA geodetic program, announced last fall, include two Geodetic Explorers (GEOS A and B), the first of which will be launched later this year, and a passive satellite (PAGEOS), similar to Echo I, scheduled for launch in the first half of 1966.

The geodetic satellite program is directed by NASA with the Department of Defense and the Department of Commerce as principal participants.

The BE-C project is part of the scientific and space exploration efforts of NASA's Office of Space Science and Applications. Project management of the satellite is assigned to the Goddard Space Flight Center, Greenbelt, Md.

Working with Goddard are the University of Illinois, Pennsylvania State University, Stanford University, the Central Radio Propagation Laboratory of the National Bureau of Standards, an agency of the U.S. Department of Commerce, and the Johns Hopkins University's Applied Physics Laboratory (APL) which designed and built the satellite.

The electron density probe experiment was built at Goddard.

The laser experiment is directed by NASA's Office of Advanced Research and Technology, under Goddard project supervision. The laser propagation devices were built by Goddard.

The radio attenuation measurement experiment also is directed by OART with project supervision assigned to the Langley Research Center.

The satellite-borne silica reflectors were produced by Boxton-Beel Co., Brooklyn, N.Y. The reflector array was assembled by General Electric Company's Space Technology Center, Valley Forge, Pa.

(END OF NEWS RELEASE; TECHNICAL BACKGROUND FOLLOWS)

SCIENTIFIC OBJECTIVES

The overall scientific objectives of the Beacon Explorer-C may be summarized as follows:

Geodesy

Basic geodetic investigations to be carried out by the satellite are concerned with gravimetric geodesy -- measuring variations in the Earth's gravitational field. Gravimetric geodesy involves the detailed study of changes in the satellite's orbit by using the Doppler shift technique with radio signals. The Doppler beacon systems on board have two coherent unmodulated continuous wave transmitters using frequencies in the 162 and 324 megacycle range.

Results from these investigations, coupled with those from future geodetic satellites in the NASA series, will aid in more precise mapping of the Earth's surface and help broaden our understanding of the Earth's gravitational field.

Benefits expected from geodetic satellite studies include the potential to improve world-wide navigation for ships at sea and the possibility of obtaining greater accuracy in calculating satellite and rocket trajectories.

Data obtained also should aid in understanding the basic phenomena of gravitational fields and in learning how this knowledge can be applied to other celestial objects.

Satellite-produced information will complement surface gravity measurements and provide a basis for exploring apparent correlations between regions of low terrestrial gravity with regions of excess heat flow from the Earth's interior.

Dr. R. R. Newton of the Johns Hopkins University Applied Physics Laboratory is the geodetic investigation.

Ionosphere Survey

The ionosphere survey portion of the BE-C mission, although no longer a primary scientific objective, remains unchanged from Explorer XXII. It involves the global effort to map the ionosphere using the network of 86 ground stations located in 36 different countries operated by 62 scientific organizations on a voluntary basis. (See map of station locations).

Radio signals sent by the satellite are received by the ground stations when the satellite is within range. Study of changes in the radio signals as they pass through the ionosphere gives network scientists data on the electron content of the ionosphere at a given time and place. As with Explorer XXII, information will be exchanged through the Scientific Data Center operated by the Goddard Space Flight Center, Greenbelt, Md.

Analysis of signals transmitted by the satellite's beacon transmitters will help scientists determine the total electron content of a vertical cross section of the ionosphere between the satellite and the Earth. This information will aid in understanding the behavior of the ionosphere related to latitude, time of day, season and solar cycle.

Similar information is being sent by Explorer XXII, orbiting at an angle of inclination of 80 degrees. The inclination for BE-C will be 41 degrees.

The beacons carried by BE-C are described as four coherent unmodulated continuous wave transmitters. The frequencies used are 20.005, 40.010, 41.01 and 360.00 megacycles. The signals are picked up by ground stations in the global network.

A typical ground station, costing less than $5,000, consists of straight dipole antennas, three radio receivers, a timing device and a recorder.

Electron Density and Temperature Probe

The electron density and temperature experiment, provided by Goddard, is an electrostatic probe designed to provide a means for measuring directly electron densities and temperature in the immediate vicinity of the satellite. This information, telemetered to ground stations, will help scientists interpret integrated electron-density measurements at the starting point of the ionosphere beacon signal.

Laser Experiment

Continuing the laser (light beam) experiments inaugurated by Explorer XXII, NASA scientists will extend the study of techniques required for deriving geodetic and orbital information.

The rate of return of the light beam to a ground device capable of recording the return pulse is the basis of a satellite optical tracking system being developed by the Goddard Space Flight Center. These time measurements, coupled with angular data, will precisely locate orbiting spacecraft and expected to provide more accurate tracking methods than those currently in use.

Results also may lead to a more definite determination of irregularities in the Earth's shape.

Experience gained in the laser experiment will aid development of high-capacity optical communications systems between Earth and spacecraft deep in space.

Ground stations experimenting with Explorer XXII experienced difficulty in confirming the return of the laser beam from the satellite due to atmospheric interference and distortion.

This problem accounts for the only change in the laser experiment from Explorer XXII the addition of a light-sensitive detector on board the spacecraft.

When the laser beam strikes the satellite, the detector will convert the light to electrical energy and amplify it. The spacecraft commutator will send a signal to the ground to confirm the strike.

An array of 360 fused silica reflectors is mounted on the spacecraft to reflect beams of light sent by pulsed ground laser transmitters when the satellite is within range and has been picked up by telescope.

The reflected light received by the telescope automatically will be amplified by a photomultiplier which converts the optical impulse to an electrical signal.

The laser detector was built by APL.

Radio Attenuation Experiment

A secondary experiment sponsored by the Langley Research Center will be carried by the Scout vehicle which will launch the BE-C. It concerns the exhaust of the second stage Castor rocket engine.

In the upper atmosphere and in space, combustion gases rushing from a rocket engine nozzle do not form a compact jet but instead fan out into a spreading shape engineers call a rocket plume. The plume becomes wider as atmospheric pressure decreases.

Ionized gases in the rocket plume can block radio transmissions in much the same way that radio blackouts occur on reentering spacecraft because of the hot, ionized gas cap. The plume can also disturb the ordinarily smooth airflow along a launch vehicle, in some cases even circulating exhaust gases in a forward direction. This may interfere with normal radio transmissions from a launch vehicle.

Attached to the Scout near the nozzle end of the second stage Castor will be two external pods containing reservoirs of four materials to be injected into the rocket plume while the engine is firing. Material injection is known to be one effective way to allow radio waves to pierce the region of ionized gas, and the four substances will be tested to compare their effectiveness. Total weight of the two pods loaded for flight is 125 pounds.

Materials selected for the experiment are freon, water, argon and nitrogen. Their basic properties differ, and the effect of each on signal recovery will be studied. The argon and nitrogen serve also as pressure sources to expel the freon and water from their containers. A timer and valve system control release of the materials in proper sequence.

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The Langley Research Center experiment is a part of Project RAM -- the initials stand for Radio Attenuation Measurements -- headed by Theo E. Sims.

Beacon Explorer-C Fact Sheet

Launch	On or about March 30, 1965 NASA Wallops Station, Wallops Island, Va. Four-stage Scout launch vehicle
Apogee	670 statute miles (1,080 kilometers)
Perigee	620 statute miles (1,000 kilometers)
Inclination	41 degrees
Period	One hour, 45 minutes
Lifetime	One year
Weight	132 pounds
Main Structure	Octagon, 18 inches in diameter, 12 inches high
Appendages	Four solar panels, ten inches wide, five and one-half feet long. Two solar panels with five-foot long/whip antennas, two panels with short antennas. Two short electron density probes protruding from top and bottom of main satellite body. One short command receiver antenna from main body.
Power System	
Power Supply:	Solar cells mounted on four panels charging 26 nickel-cadmium batteries
Voltage:	24 volts unregulated
Power:	10 watts nominal power

Communications and data-handling system

Telemetry:	Three basic units: (1) 35-channel amplitude modulation (PAM) commutator, (2) eight channel pulse duration modulation (PDM) commutator and (3) seven telltale register functions with pulse code modulation (PCM) format.
Transmitter:	400 milliwatts at 136.74 mc on a continuous basis
Tracking:	Stations of the world-wide Space Tracking and Data Acquisition Network (STADAN) operated by the Goddard Space Flight Center.

Scout Launch Vehicle

Scout is a four-stage solid propellant rocket capable of carrying payloads of varying sizes on orbital, space probe or re-entry missions. It is 72 feet long and weighs about 20 tons at lift-off.

Scout was developed by NASA's Langley Research Center, Hampton, Va. It is manufactured by Ling-Temco-Vought, Inc., Dallas.

Its four motors are interlocked with transition sections which contain guidance, control, ingition, instrumentation systems, separation mechanisms, and the spin motors required to stabilize the fourth stage. Guidance is provided by a strapped-down gyro system and control is achieved by a combination of aerodynamic surfaces, jet vanes, and hydrogen-peroxide jets.

Scout is capable of placing a 240-pound payload into a 300-mile orbit or of carrying a 100-pound scientific package 7,000 miles out from Earth.

Scout stages include the following motors:

First stage:	Algol IIB - 105,000 pounds thrust, burning 68 seconds.
Second stage:	Castor I - 62,000 pounds thrust, burning 42 seconds.
Third stage:	Antares (ABL X-259) - 22,000 pounds thrust, burning 36 seconds.
Fourth stage:	Altair (ABL X-258) - 5,000 pounds thrust, burning 24 seconds.

The Beacon Explorer Team

The following key officials are responsible for the BE-C satellite program:

NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications

Marcel J. Aucremanne, Program Manager, Physics and Astronomy Division of the Office of Space Science and Applications (OSSA)

J. D. Rosenberg, Manager of Geodetic Satellite Program, Physics and Astronomy Division of OSSA

Dr. John M. Walker, Chief of Communications and Tracking Branch, Office of Advanced Research and Technology

Ro H. Chase, Laser Project Scientist, OART

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Goddard Space Flight Center

Dr. Harry J. Goett, Director

Dr. John W. Townsend, Jr., Associate Director, Office of Space Science and Satellite Applications

Frank T. Martin, Project Manager

Robert E. Bourdeau, Project Scientist

John T. Shea, Project Coordinator

Larry H. Brace, Electron Density Experiment

Dr. Henry H. Plotkin, Laser Project Scientist

Langley Research Center

(Radio Attenuation Measurement Experiment)

Fred L. Staggs, Payload Manager; Henry Elksnin and Wallace R. Conway, structures engineers; Otis J. Parker, systems engineer, Gilbert F. Van Zandt, instrumentation engineer.

(Scout Launch Vehicle)

Eugene D. Schult, Head, Scout Project Office; Thomas Moore, Payload Coordinator; Paul E. Goozh, Scout Project field operations engineer; R. Donald Smith, Scout propulsion engineer; Albert J. Saecker, Langley Research Center Test Director.

Wallops Station

L. A. Teletski, Wallops Station Project Engineer

Robert T. Duffy, Wallops Station Test Director

Applied Physics Laboratory, Johns Hopkins University

R. R. Newton, Scientific Investigator, Supervisor Space Research and Analysis Branch.

Donald R. Biauco, Project Engineer, Space Research and Analysis Branch

Participating Organizations

University of Illinois

Pennsylvania State University

Stanford University

Central Radio Propagation Laboratory, U.S. Bureau of Standards

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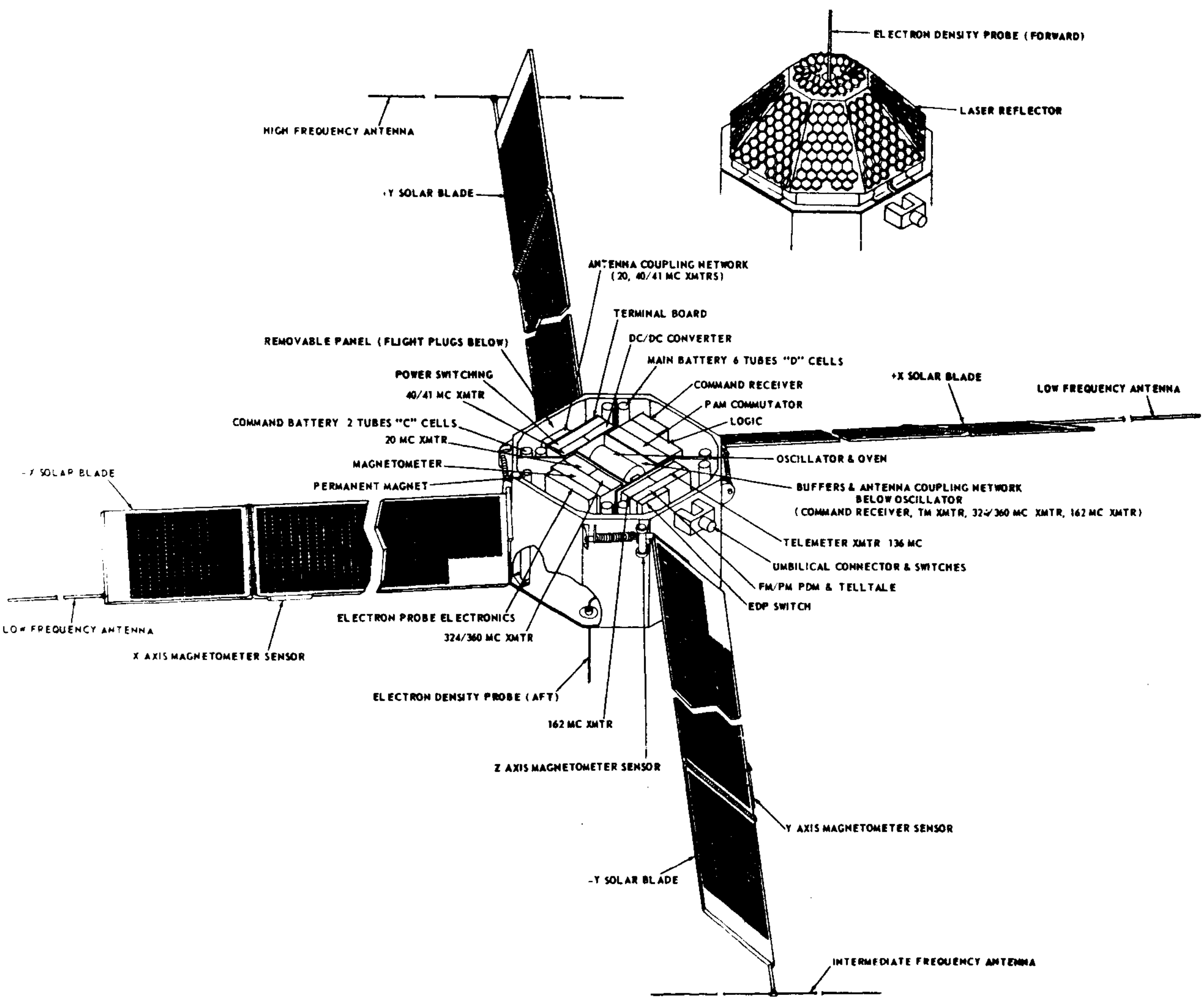
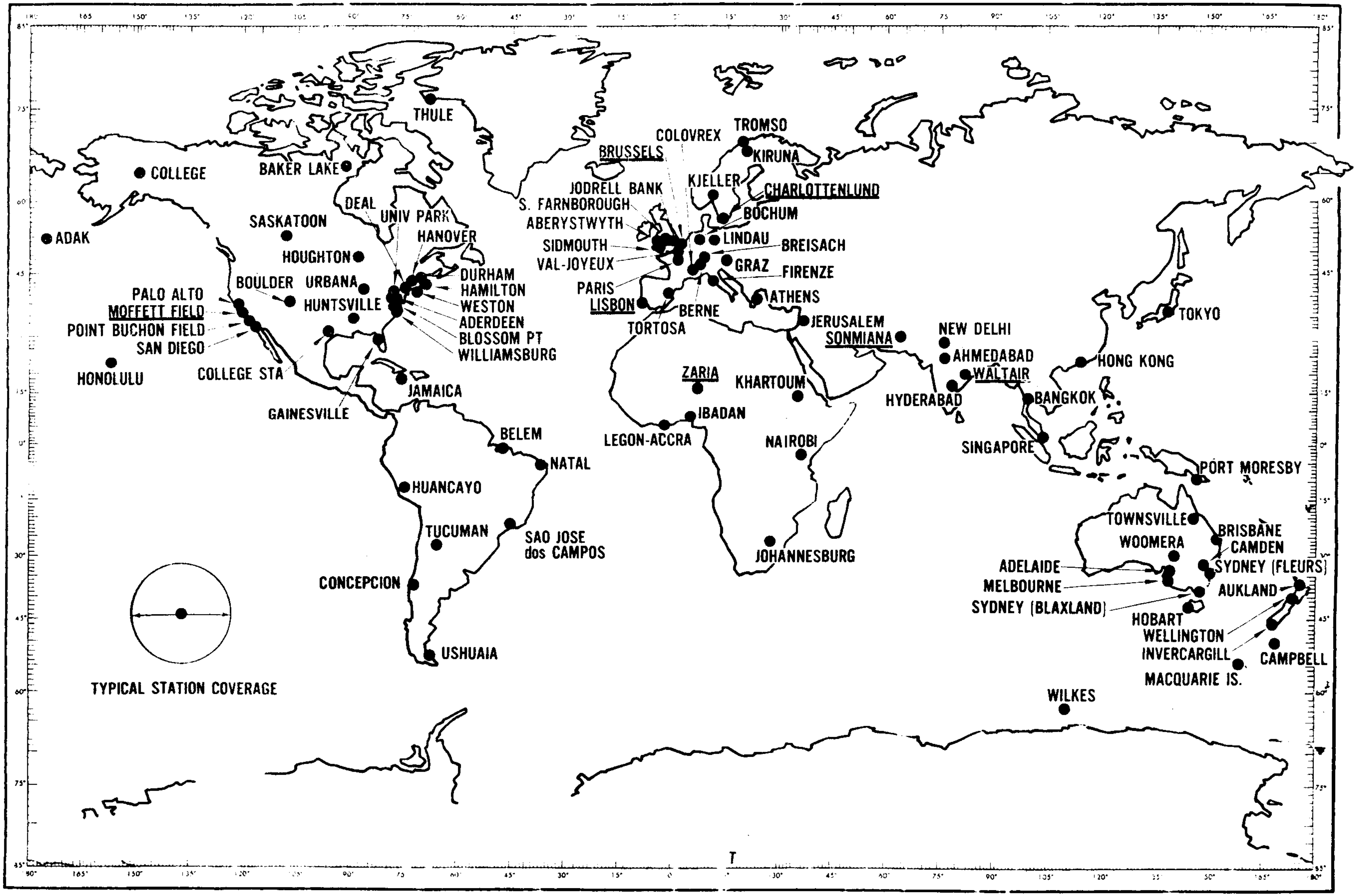
BEACON EXPLORER C

CUTAWAY VIEW



BEACON EXPLORER SATELLITE MONITORING STATIONS



Stations underlined added since launch of Explorer XXII